Developing Smartphone Integrated Soil Sensor for African Smallholder Farmers using Artificial Intelligence toward Sustainable Soil Nutrients Management

ADAM MUHAMMAD ADAM

MRes + PhD Student

SENSOR CDT

UNIVERSITY OF CAMBRIDGE

CAMBRIDGE AFRICA

GLOBAL FOOD SECURITY

About me

- Bachelor and Masters Degrees in **Soil Science** with Specialization in **Soil Fertility and Plant Nutrition**.

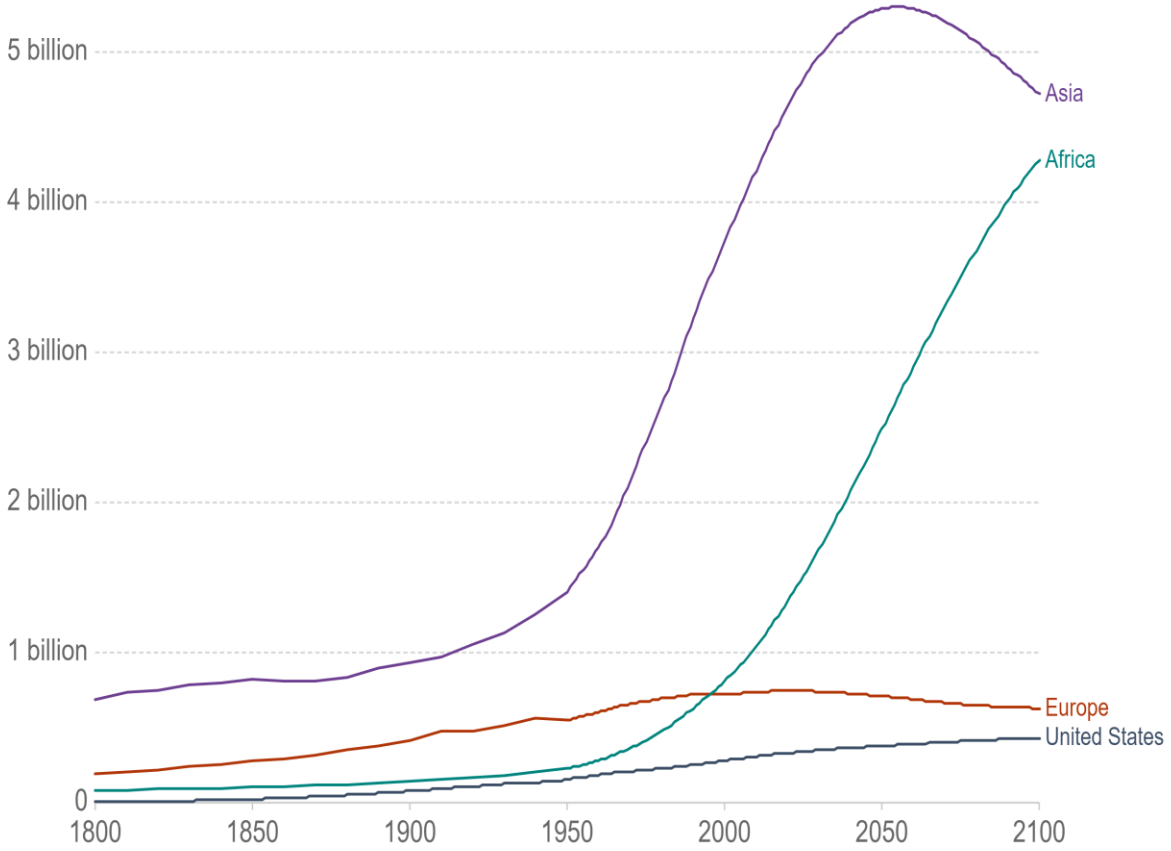
- **Research Assistance** in TAMASA project for 4 years

- **Research Fellow** in CDA (an African Centre of Excellence)

Mind the Gaps…

Population, 1800 to 2100

Historical estimates of population, combined with the projected population to 2100 based on the UN's medium variant scenario.

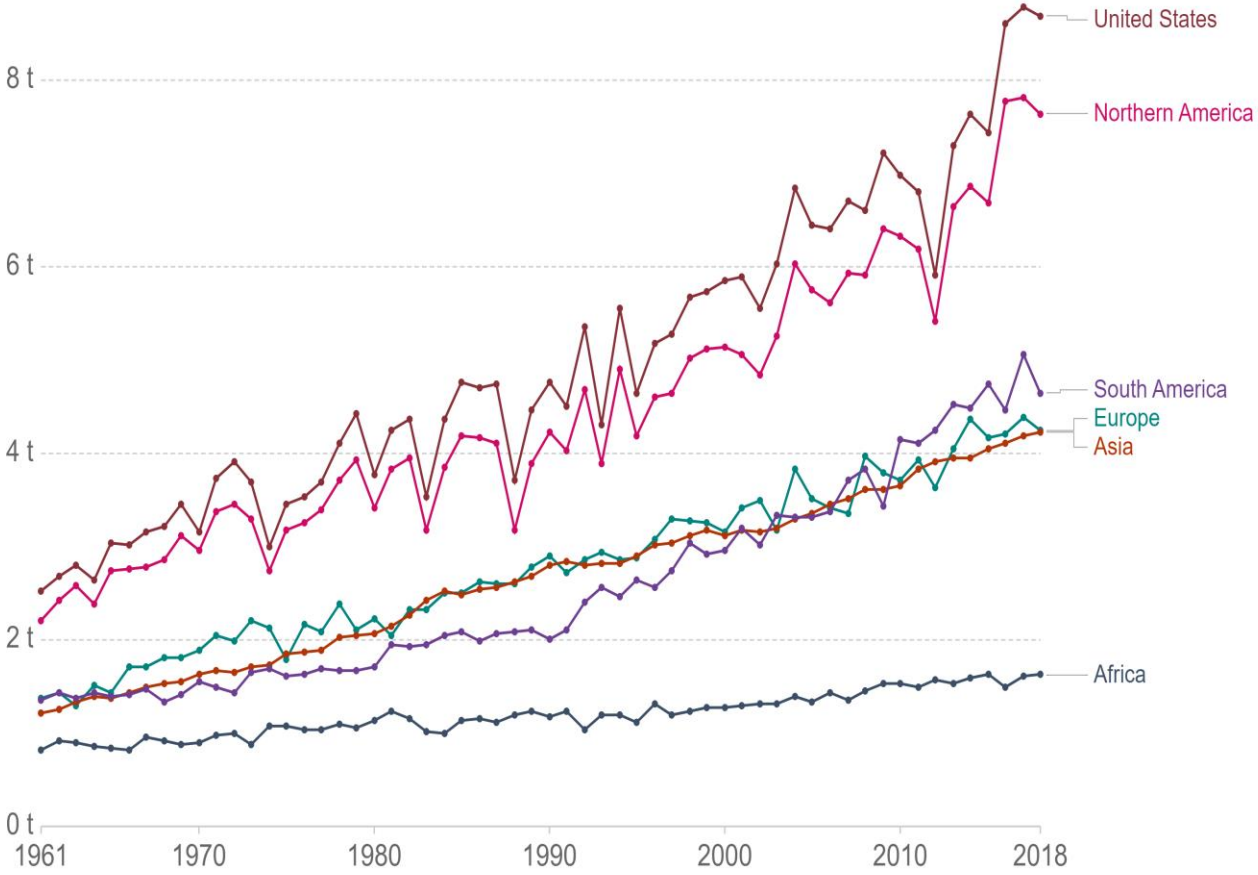


Source: Gapminder & UN Population Revision (2019) Medium Scenario
Note: Historical country data is shown based on today's geographical borders.

OurWorldInData.org/future-population-growth • CC BY

Cereal yield, 1961 to 2018

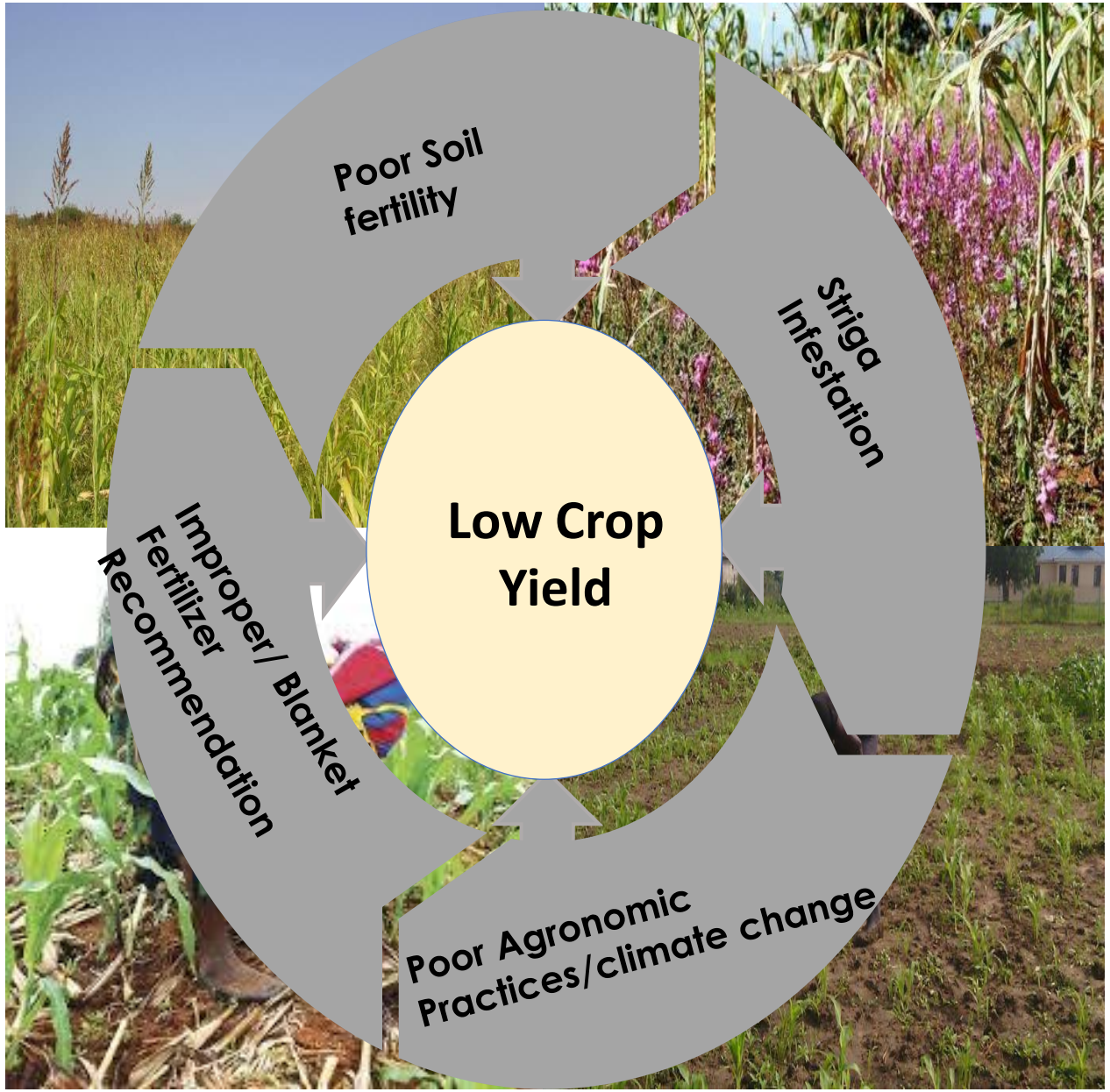
Cereal yields are measured in tonnes per hectare. Cereals include wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains.



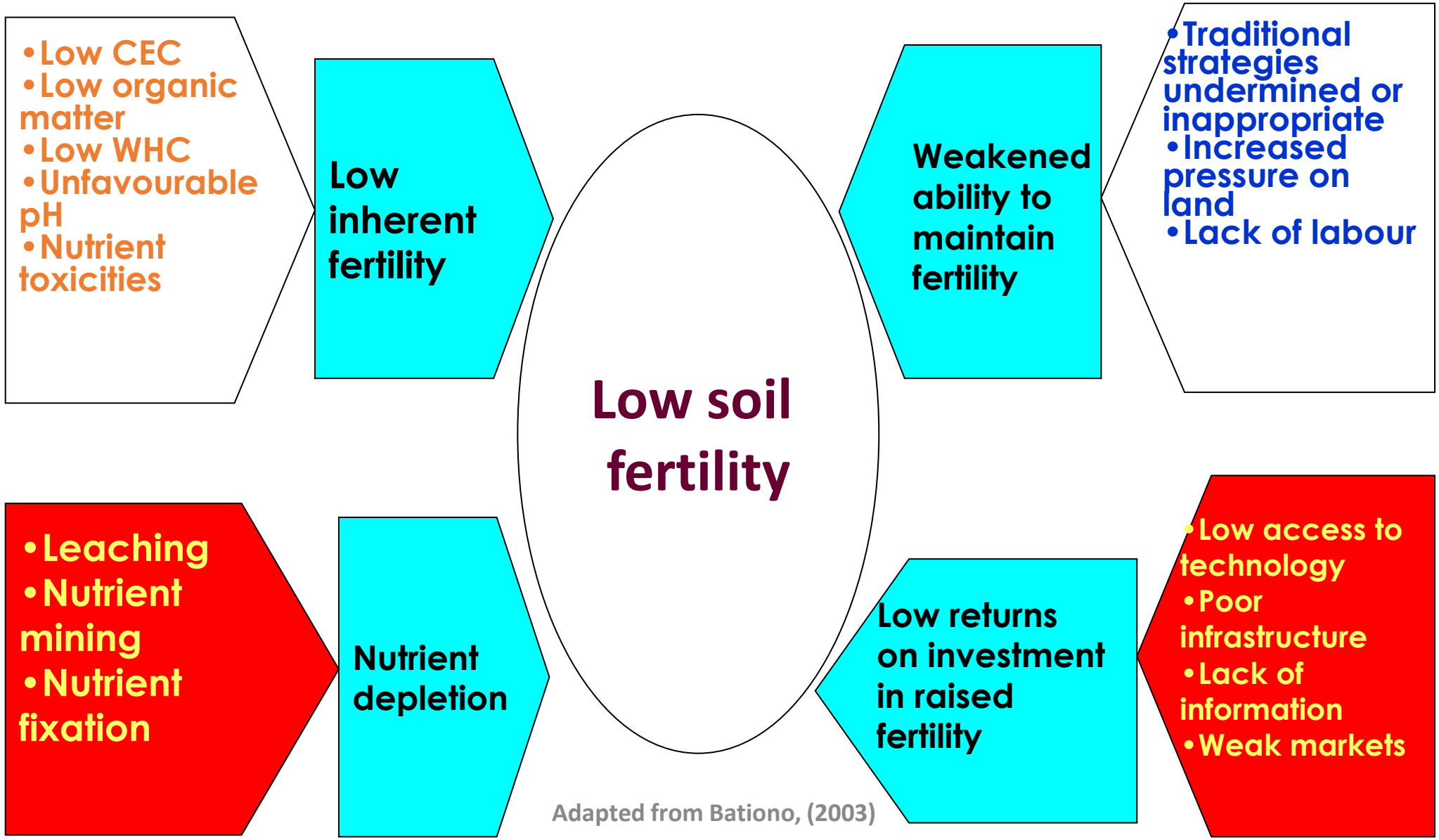
Source: UN Food and Agriculture Organization (FAO)

OurWorldInData.org/crop-yields • CC BY

- The low yields obtained in Africa can be attributed to multiple (and often inter-related) factors, however, poor soil fertility and improper nutrients management are the top primary constraints.



Biophysics, chemical and socio-economic factors contributing to low soil fertility and poor productivity in Sub-Saharan Africa



Adapted from Bationo, (2003)

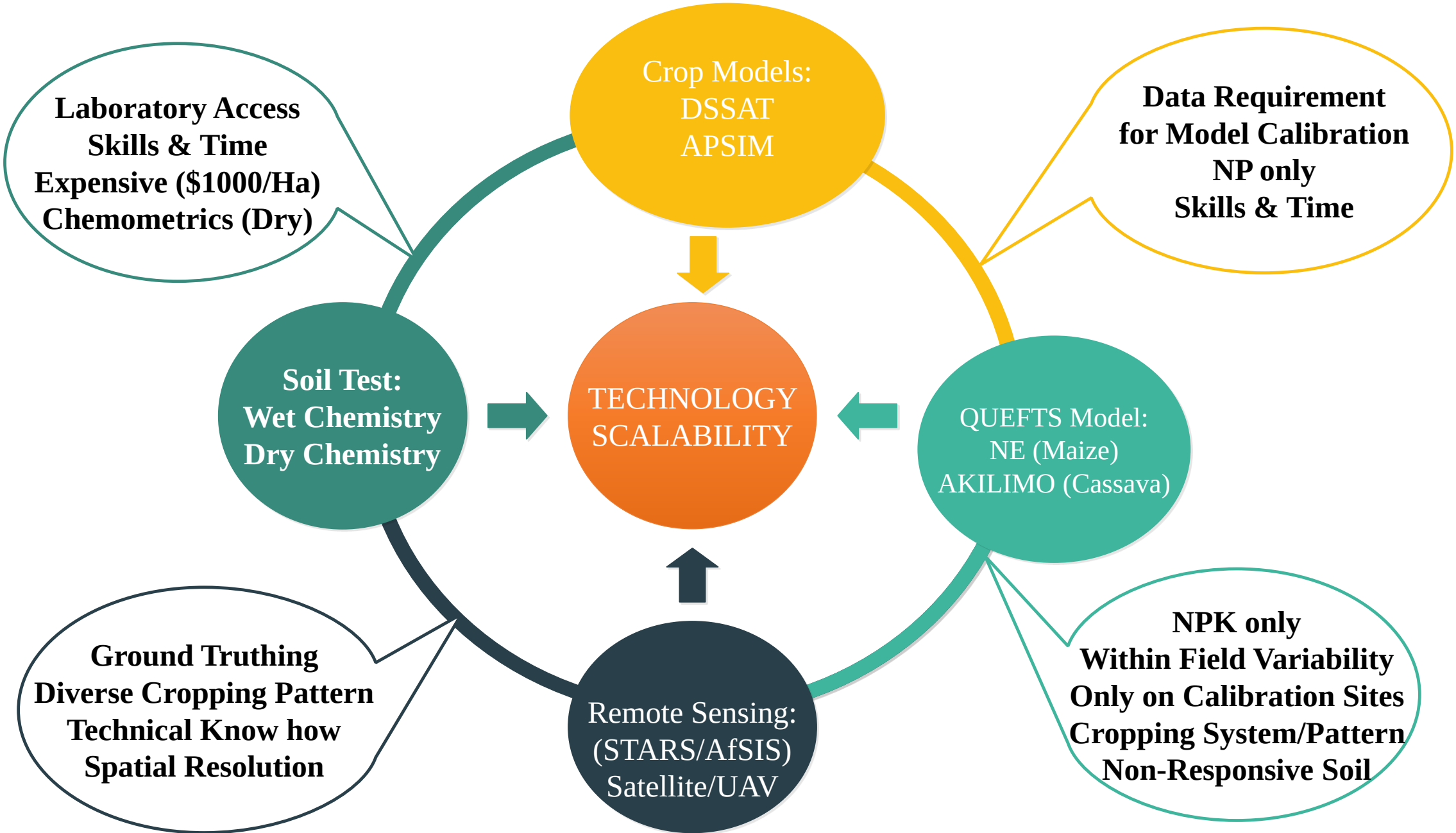
Way Forward to African Agriculture

Adopting **Sustainable Nutrients Management Strategies** that will

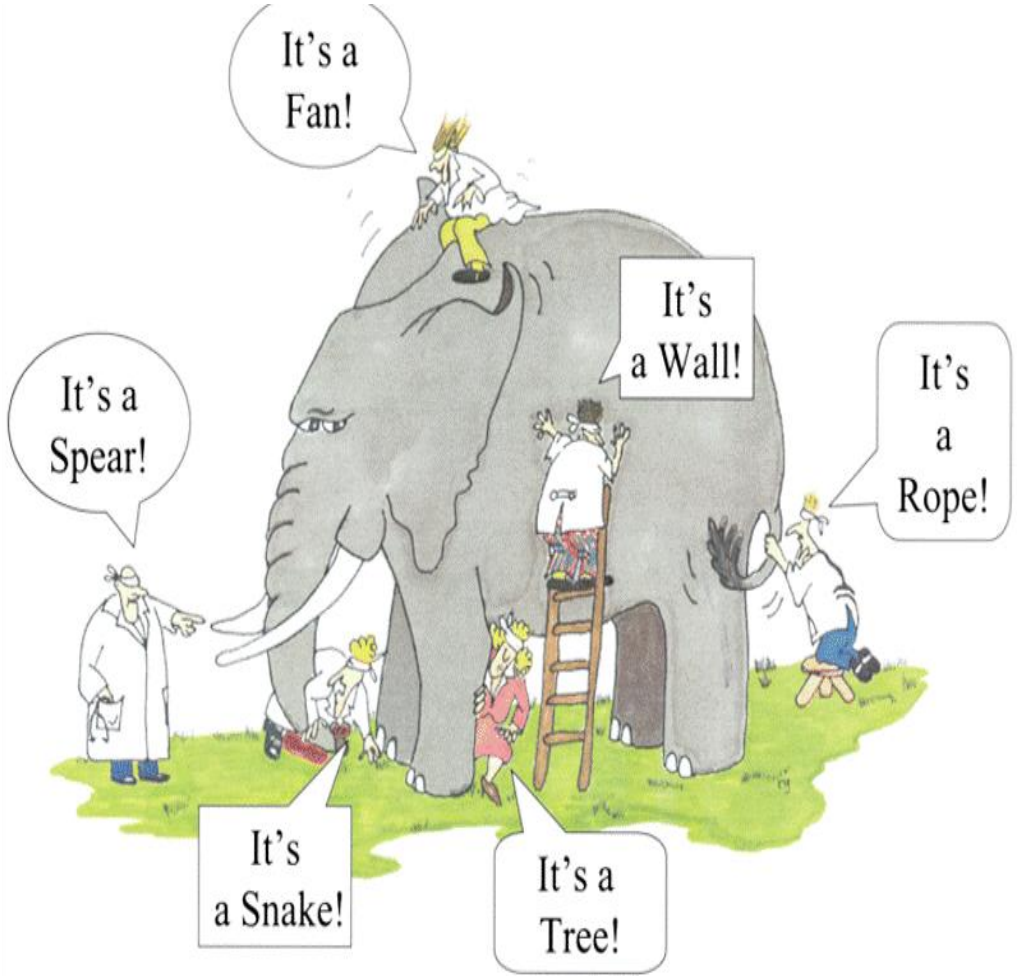
- Use fertilizer more efficient,
- Increase crop yields,
- Reduced environmental impacts and
- Minimize emissions of greenhouse gases

Several technologies have been developed toward achieving sustainable nutrients managments in Africa

Limitations in Current Technologies

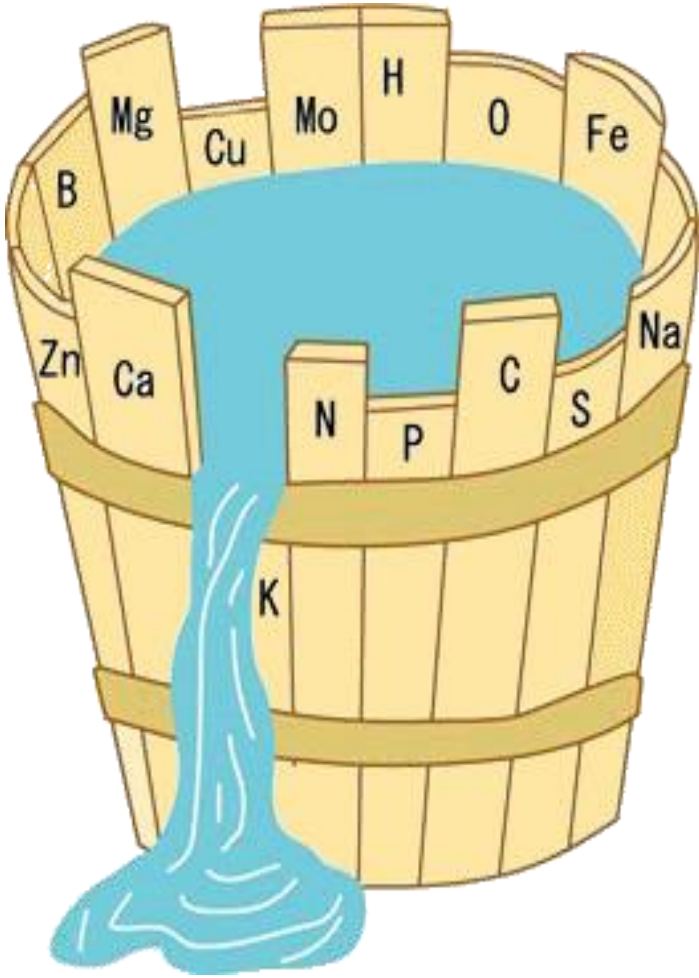


KEY MESSAGE!



Previous Researches

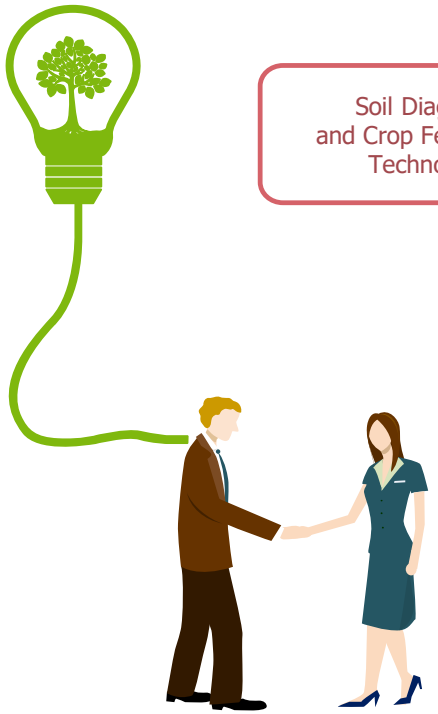
Smallholder Farmers



Liebig's Law of Minimum

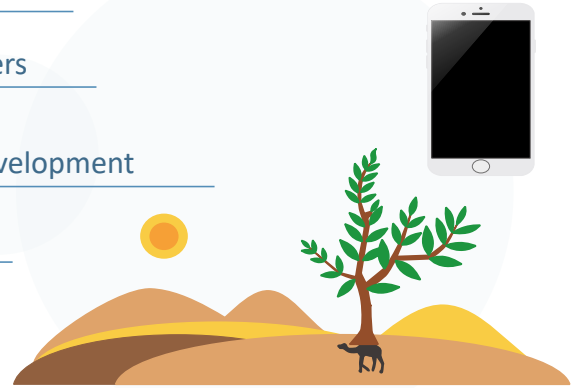
Future Research = *HOLISTIC APPROACH*

Cam-SISSA (Cambridge Smartphone Integrated Soil Sensor for Africa)



Soil Diagnosis and Crop Fertilization Technology

1. What's the problem
   - Site-Specific Fertilizer Recommendation
   - Crop-Spefic Fertilizer Recommendation
   - Optimize Crop Productivity & Soil Health
2. Current Situation
   - Very Expensive Soil Diagnosis Method
   - Requires High Technical Know & Time Consuming
3. Technology Goals
   - Efficient, Cheaper & Easier Method for Soil Diagonosis
   - Rapid and Convinient Method of Crop Fertilization
4. Gains
   - To Reduce Risks, Uncertainties & Production Costs
   - To Maximize Productivity & Maintain Soil Health
5. Targets
   - Individual Farmers/Farm Advisors
   - Farmers Cooperatives/Agro-Dealers
6. Milestones
   - Sensor Design, Calibration & Development
   - Technology Validation
   - Fields Demonstration



Sensor Design and Fabrication

Smartphone Built-in Sensor

Smartphone Flashlight Modification

Add-on Sensor

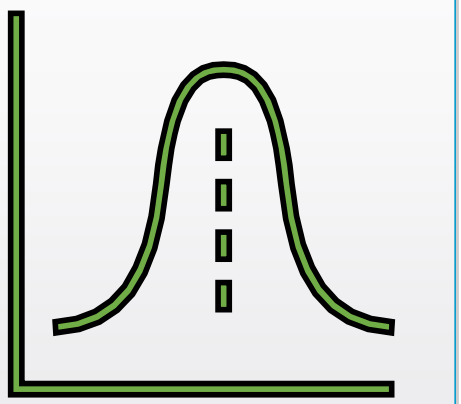
Super Process

Sensor Working Principle: Molecular Spectroscopy

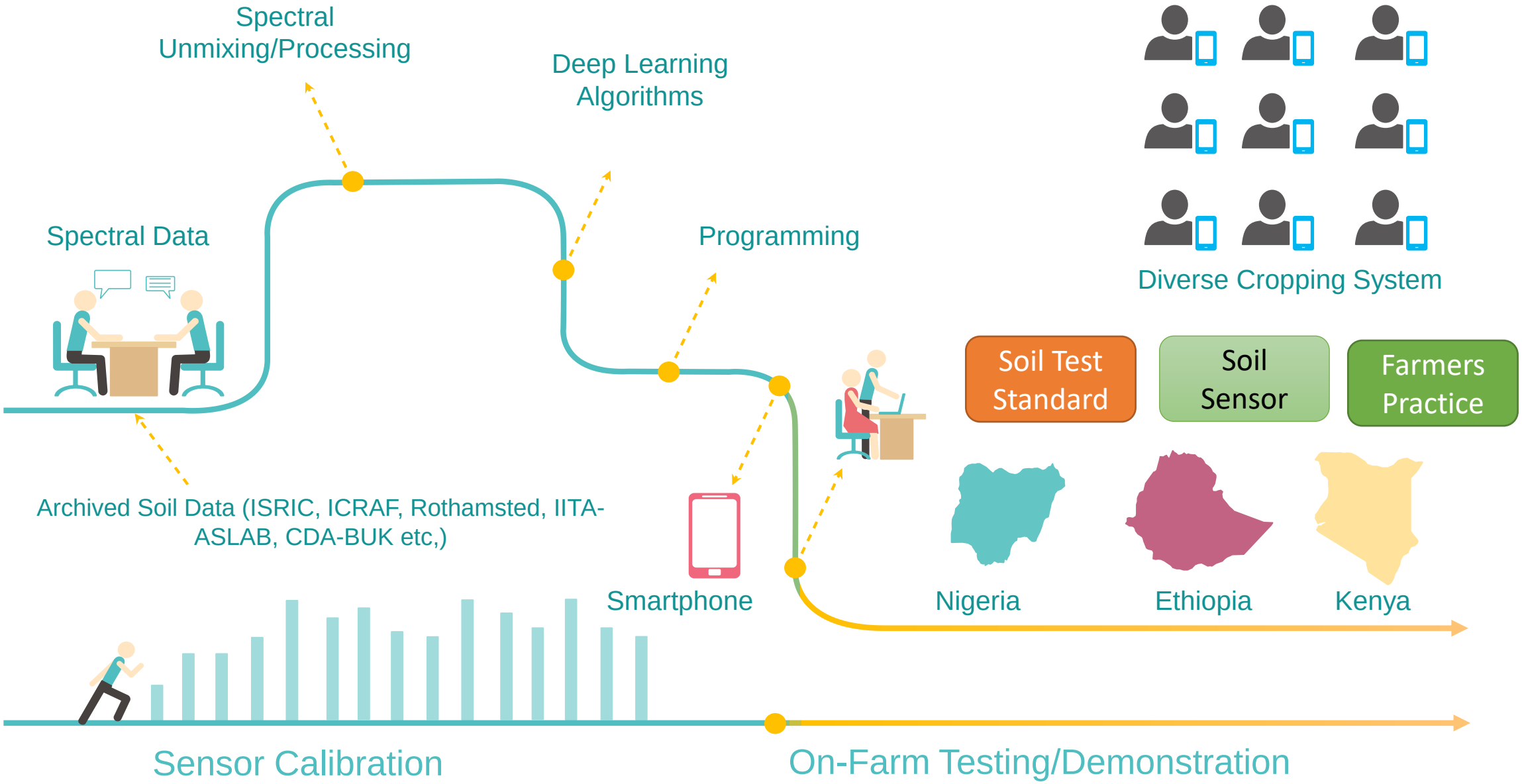
Detector

Sample

Results



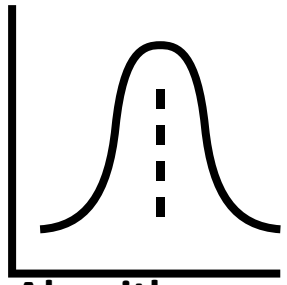
Sensor Calibration and Validation



How the Technology will Work!

Long term Weather Data (Rainfall, Temperature & Solar Radiation)

Spectral Acquisition



- **Algorithms**

Soil Analysis Results

N,P,K, SOC, S, B, Clay, pH, Zn, Cu, Mn, Fe, Sand etc.

Soil Test-Yield Response Relationship

Crop Suitability
Mono/Intercropping

4Rs Nutrients Stewardship

Thank you for your attention!

Questions?